



## ENDLESS CASTING ROLLING SYSTEM WITH SINGLE CASTING STAND

### Field of the invention

The present invention relates to an integrated plant for the production of elongated metal products, such as bars and rods, and the like. More particularly, the invention involves an integrated plant in which an elongated metal product is produced in a continuous caster and is thereafter directly operated on in a rolling mill apparatus disposed in-line with the caster in a substantially continuous sequence.

### Background of the invention

It has commonly been the practice to separate the caster and the rolling mill in order to enable product, which has been prepared by a variety of preliminary processing procedures, to be preliminarily processed and thereafter introduced to the rolling line. More recently, since the development of "hot charging" processes, it is known to provide transport means and storage devices for handling cut to length billets or blooms and to introduce them while hot to a heating furnace. While this practice saves and reduces the need for billet storage, it suffers the drawbacks of reduced material output due to the need for cropping the cast product into short lengths, the presence of short bars in the bed, and the generation of scale in the furnace.

Although several of these defects have been overcome by the method for the continuous casting of long products as described in European Patent Application No. EP 0 761 327, of the same applicant hereof, the disclosed method suffers from its own drawbacks that an induction furnace is used before the rolling process to increase the billet surface temperature and then enable its equalization in an air section. This concept is no longer applied in the present invention, according to which the furnace is used to guarantee the stay time after the equalization. Furthermore, in the present invention there is the possibility of having a longer heating time and thus a softer heating curve. This reduces the thermal stress on the material and improves both its quality and the temperature homogeneity through the bloom cross section.

It is to the amelioration of these drawbacks that the present invention is directed.

### Summary of the invention

In accordance with the present invention there is provided apparatus for the production of elongated rolled product comprising a continuous casting equipment, a rolling mill positioned downstream of the continuous casting equipment in alignment with the casting line, and a tunnel furnace disposed intermediate the continuous casting equipment and the rolling mill along the line of product. The tunnel furnace has a length of approximately 100 m and it is designed to achieve a soft heating profile for the bar.

It is accordingly an object of the invention to provide a production line which is adapted for the production of elongated product, particularly, in the form of bars in which the yield of the plant is optimized.

It is a further object of the invention to provide a line for the production of elongated bar product in which the size of the plant is minimized, thus to provide production efficiencies.

It is another object of the invention to provide a casting and rolling system in which the following improvements should be achieved:

- a. immediate charging into the furnace right after the continuous caster;
- b. gradual equalization of the billet temperature;
- c. stay time sufficient to guarantee the metallurgical improvement of the product, but not too long to avoid an excessive decarburization.

For a better understanding of the invention, its operating advantages and the specific objectives obtained by its use, reference should be made to the accompanying drawings and description which relate to a preferred embodiment thereof.

### Brief description of the drawings

Fig. 1 is a schematic representation illustrating the casting/mill area object of the present invention.

Fig. 2 is a sectional view of the tunnel furnace taken along line A-A of Fig. 1.

### Description of the preferred embodiments of the invention

The disclosed invention is particularly directed to a plant for the production of bars, wire, rod, rebar, or shaped beams or angles, and the like, in which the bloom is directly linked from caster to the rolling mill without having to pass

through a traditional heating furnace.

The process comprises:

- a. casting the product in a one-line high-speed caster 12;
- b. heating, equalizing and holding in a tunnel furnace 13;
- 5 c. descaling in a descaler 14 and directly rolling in a rolling mill 15.

In Fig. 1 the production line is schematically shown as containing continuous casting equipment 12 including a mold 20 which, as is well known, receives molten metal from a tundish (not shown), or the like, and delivers a bloom 11 to a conveyor 24, typically a roll conveyor, suitable for conveying high temperature metal product.

The illustrated production line contains an in-line shear 18 which may be of the blade or flame-type and that is used to cut the billets during the change of the rolling sequence (bar section) or during emergency events that may occur to the continuous caster or to the rolling train. Along the line a quenching box 16, used for those steels which have nitride precipitation problems, is inserted. A tunnel furnace 13, whose principal function it is to heat up and to equalize the temperature of the bloom and to bring it to a rolling temperature prior to its being passed to the rolling mill 15, as hereinafter more fully described, is provided upstream of the roughing mill stand 15.

Advantageously, a descaling assembly 14, as shown in Fig. 1, is disposed in conveyor line 24 intermediate the discharge end of the tunnel furnace 13 and the entrance to the roughing mill stand 15. The descaling assembly 14 may be of any well known type but preferably is of the water-operated type including rotary nozzles (not shown) providing a high pressure impact and a low overall rate of water flow so as to reduce to a minimum the loss of temperature from the bloom 11 passing to the rolling mill.

Between the tunnel furnace and mill inlet, in an advantageous position between descaler and mill, an on-line conditioning device can be provided which enables an efficacious elimination of surface defects before entering the mill. The device may comprise in-line grinding systems or in-line scarfers using a special flame for eliminating the billet surface layer.

The tunnel furnace 13 may be heated by any of a number of available heating

sources including free flame burners, radiating pipes, induction heaters, or any combination of these, either with or without a protective atmosphere. In the tunnel furnace 13 the conveying rollers 35 are enclosed within walls 36 having a thermal resistant lining.

5 The principal aim is to obtain an almost continuous feeding of the rolling mill 15 using an extremely compact and rational layout upstream the mill. In this way, considerable savings can be achieved both in terms of equipment investment and operating costs.

The continuous casting machine 12 must, therefore, be linked in the most direct  
10 way with the rolling mill 15. What must be done in the gap between the continuous caster and the rolling mill is the equalization of the billet temperature to that required for the rolling process. This temperature is then maintained for a sufficient time so as to guarantee a quality improvement from the metallurgical point of view, but not too long as to prevent an excessive decarburization of the  
15 product inside the furnace.

The present invention allows the immediate charging into the active tunnel furnace 13. In this way it is possible to avoid temperature reduction before the charging into the tunnel furnace 13 and it is not necessary to increase the surface temperature up to a value much higher than that of the core temperature thus  
20 avoiding the wait for the equalizing process in air as required in the system disclosed in European Application No. EP 0 761 327.

By changing the capacity of the tunnel furnace 13 it is possible to obtain the temperature profiles desired inside the furnace.

In normal functioning conditions there is only one bloom 11 which goes from the  
25 caster 12 to the rolling mill train 15. The casting speed therefore must be equal to the minimum allowed rolling speed. This is guaranteed by innovative high-speed casting.

If there are stops in the rolling mill 15, for changing the rolling sequence (bar section) or for various problems, a shear 18 for cutting and the driven roll  
30 conveyors 35 for extracting the billets from the line are provided. In case of a stop of the train 15 for a few minutes to change a rolling sequence, it is possible to cut the bloom by shear 18 and to increase the rolling speed in order to create the

desired gap time between the last rolled bloom and the new one coming from continuous caster 12 at fixed speed.

Another possibility is to reduce the casting speed maintaining the rolling speed constant. If the stop time will be higher the bloom is cut to billets 12 - 14 m longs,  
5 that are put onto a cooling bed 30 and then stored.

Moreover, the possibility is maintained to feed the rolling mill 13 in the traditional way, charging the cold billets (12-14 m longs) into the re-heating furnace 40 even during continuous caster and tunnel furnace maintenance. This method unites efficiency with safety and flexibility.

10 It will be understood that various changes in the details, materials and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

**CLAIMS**

- 1 1. Apparatus for the production of elongated rolled product comprising:
  - 2 continuous casting equipment (12) for casting the product in a one-line high-speed
  - 3 caster;
  - 4 a rolling mill (15) positioned downstream of said continuous casting equipment
  - 5 (12) in alignment with said one-line high-speed caster;
  - 6 an active tunnel furnace (13) disposed intermediate said continuous casting
  - 7 equipment and said rolling mill for the immediate charging of the bloom for
  - 8 heating, equalizing and holding said bloom to a predetermined rolling temperature;
  - 9 a descaling assembly (14) included between said active tunnel furnace (13) and
  - 10 said rolling mill (15);
  - 11 an on-line conditioning device (17) between said active tunnel furnace (13) and
  - 12 said descaling assembly (14);
- 1 2. Apparatus according to claim 1, including a quenching box (16) between said
- 2 continuous casting equipment (12) and said active tunnel furnace (13);
- 1 3. Apparatus according to claim 1, including an in-line shear (18) between the
- 2 continuous casting equipment (12) and the tunnel furnace (13) which is used to cut
- 3 the billets during the change of the rolling sequence or during emergency events.
- 1 4. A method for in-line casting and rolling a bloom comprising the steps of:
  - 2 a) continuously casting a bloom in a one-line high-speed caster (12);
  - 3 b) providing a rolling mill in-line with the high-speed caster (15);
  - 4 c) providing an active tunnel furnace (13) between the high-speed caster (12) and
  - 5 the rolling mill (15) and operating said active tunnel furnace to immediately receive
  - 6 the bloom and to heat up and equalize the temperature of the bloom at a
  - 7 predetermined rolling temperature;
  - 8 d) descaling said bloom intermediate said active tunnel furnace (13) and said
  - 9 rolling mill (15);
  - 10 e) on-line conditioning the bloom between said active tunnel furnace (13) and said
  - 11 rolling mill (15);
  - 12 f) providing a quenching box (16) between said high-speed caster and said tunnel
  - 13 furnace.

FIG. 1

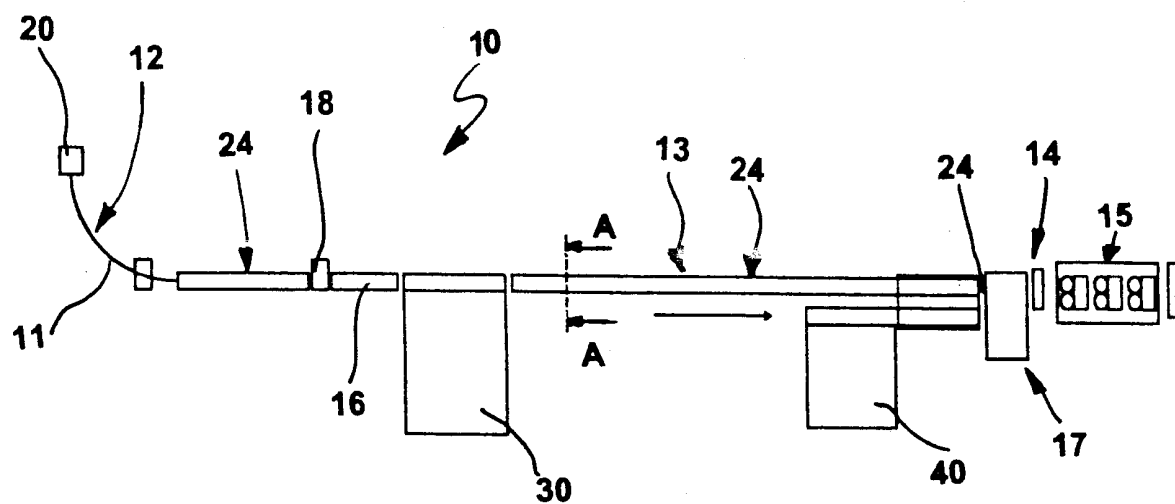
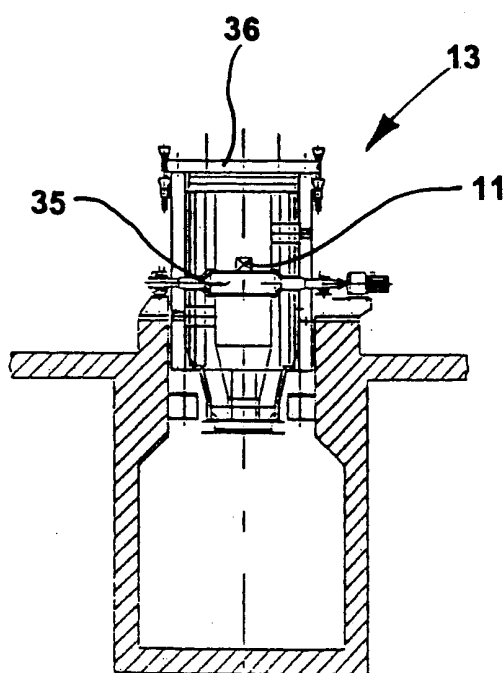


FIG. 2



# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/IB 00/00678

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 B21B1/46 B22D11/12

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B21B B22D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                           | Relevant to claim No. |
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| Y          | column 7, line 58 -column 8, line 20; claim 1; figures                                                                                                                                                                                                       | 2-4                   |
| Y          | ---<br>LESTANI M: "NEW CONCEPTS IN THE PRODUCTION OF SPECIALTY STEELS IN BARS AND COILS"<br>CAHIERS D'INFORMATIONS TECHNIQUES DE LA REVUE DE METALLURGIE, FR, REVUE DE METALLURGIE. PARIS, vol. 94, no. 10, page 1225-1236<br>XP000734342<br>ISSN: 0035-1563 | 2,4                   |
| A          | the whole document<br>---<br>-/--                                                                                                                                                                                                                            | 1                     |

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel: (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Plastiras, D

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                     | Relevant to claim No. |
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Information on patent family members

International Application No

PCT/IB 00/00678

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